Aviation Communication and Surveillance Systems

LYNX HARDWARE CHANGE IMPACT ANALYSIS (HCIA) FOR POWER AMPLIFIER & RF SWITCH UPDATES

CAGE Code	Initial Release Date	Revision Date	Document Number	Revision
1WYD3	**07-Mar-2019**	**27-Aug-2019**	**8210332-001**	**A**

Record of Revisions

Rev	Date	Authorization	Description of Change
-	07-Mar-2019	ECR018849	Initial Release
A	19-Aug-2019	ECR018849	Changed document to reflect new FCC-driven creation of 9001305-002 for the STAC1011-350B power amplifier and Mod C. Updated ACSS logo on title page.

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1 INTRODUCTION

1.1 Purpose

This Hardware Change Impact Analysis (HCIA) documents the hardware modifications, summarized in Table 1-1, due to long lead times and/or obsolescence.

Table 1-1: Summary of Hardware Modifications

No.	Assembly	Description of Modification
1	Circuit Card Assembly – NGT-9000D+	P/N 9020020-003 is revised to allow using the 9002396-001 HMC284 RF switch in place of the 9000783-001 AS186-302LF RF switch. The new switch has one less ground connection, but is otherwise physically equivalent and functionally has negligible differences.
2	Transistor, RF, High Power, LDMOS	Replaced P/N 9001305-001 with the 9001305-002 STAC1011-350B. The original part is the STAC1011-350A. Both parts use the same die, but the manufacturer changed the package, lead frame, and lead plating to address manufacturing yield and obsolescence issues. The 9001305-002 part number results from the need to identify LRUs with MOD C, not from any significant difference between the STAC1011-350A and STAC1011-350B.

Table 1-2: Lynx Hardware LRUs Affected

Part Number	Hardware Mod	Input Power	Unit Size	Affected CCAs
9200-17000-01	C	DC	Panel Mount	9020020-003,
9200-17500-01	C	DC	Remote Mount	9020020-003,

All design changes were analyzed for impact to each applicable TSO. The engineering analysis categorizes the impacts to each TSO as one of the following (per 14 CFR 21.619):

- **Minor Impact** - the applicable change has a minor impact on the TSO function. It does *not* require a major reevaluation of the substantiation data to demonstrate compliance to the TSO requirements.
- **Major impact** - the applicable change has a major impact on the TSO function and *does* require a major reevaluation of the substantiation data to demonstrate compliance to the TSO requirements.

1.2 Scope

This HCIA applies to the Lynx product line, and provides justification for the Major/Minor TSO change classification of the hardware modification.

1.3 Description of Equipment

The LYNX Platform hardware was developed by Aviation Communications and Surveillance Systems (ACSS) in Phoenix, Arizona, USA. A top-level, hardware block diagram of the Lynx Platform hardware is

shown in Figure 1-1. An additional block diagram detailing the functions specific to the RF processing is shown in Figure 1-2 because this diagram explicitly shows the coaxial interfaces to the antennas.

The following CCAs are used for implementing the functions:

- Circuit Card Assembly –NGT-9000D+

This single Circuit Card Assembly provides the internal signal routing to all internal assemblies within the LRU, the display (if installed), and to the external connector. This assembly includes the 12-28VDC power supply input filtering and conversion to regulated outputs.

The CCA Assembly also hosts the application software and contains all of the hardware for RF and I/O processing. This includes interfacing with an optional UAT/GPS receiver that is unaffected by current changes to the CCA Assembly.

Additionally, the CCA Assembly contains the circuitry to process both received and transmitted 1030MHz and 1090MHz RF signals. Received 1030MHz and 1090MHz signals are converted to a filtered intermediated frequency and routed to A/D converters for digitization and processing. The transmitter RF circuitry up-converts, filters, and amplifies the modulated signal provided by the digital circuitry via a D/A converter.

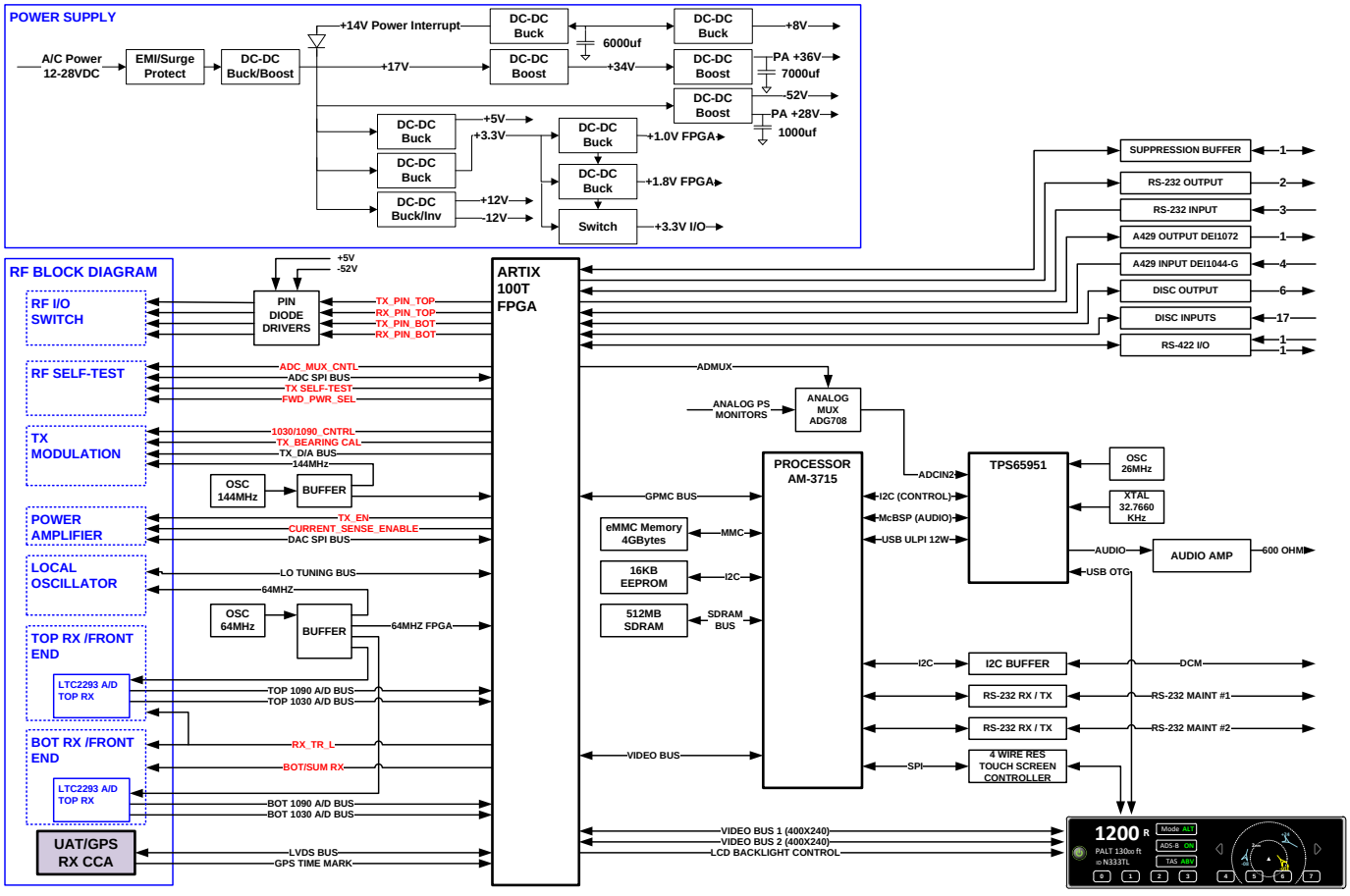

Figure 1-1: NGT-9000 Platform Hardware Block Diagram

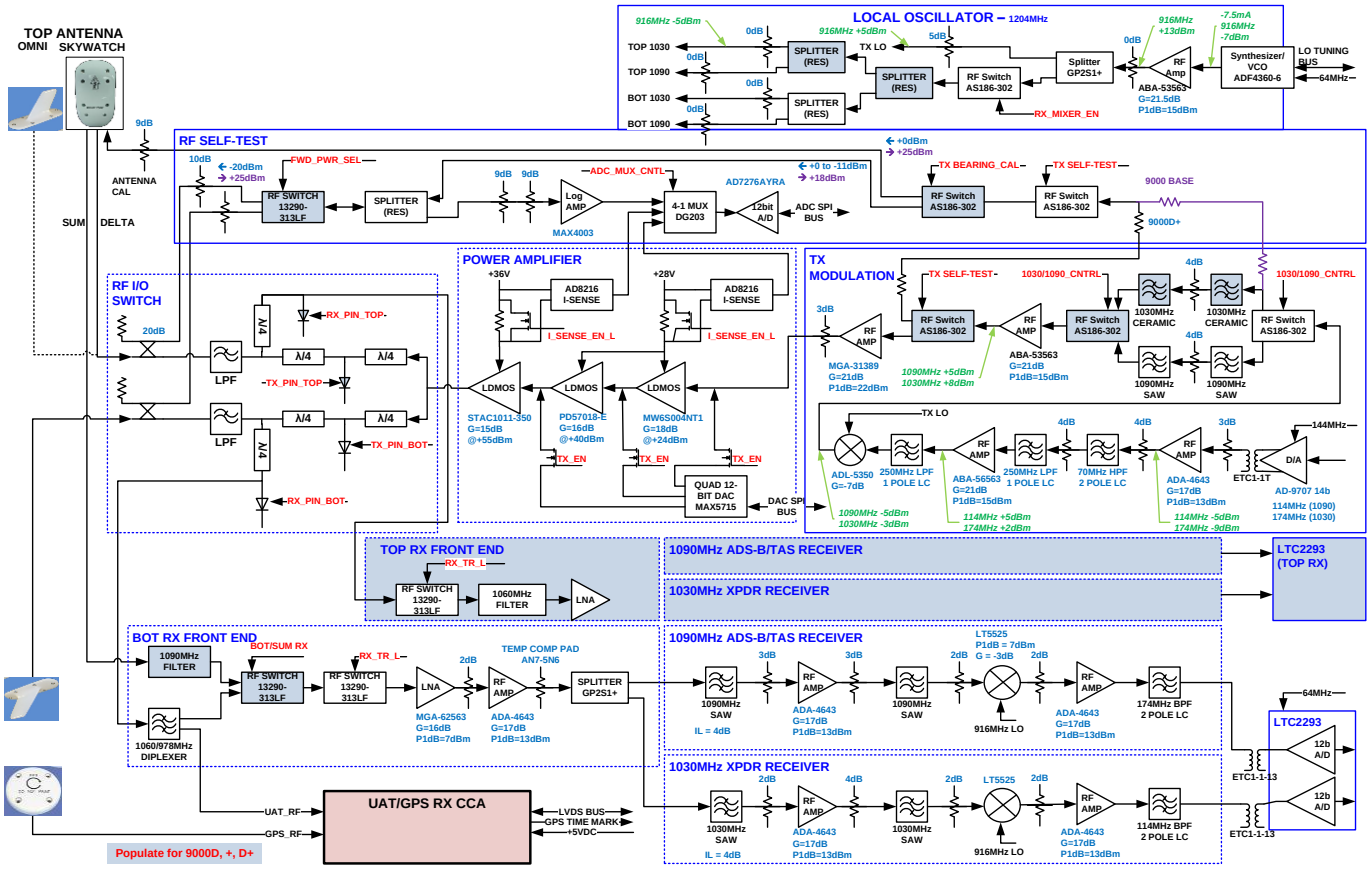

Figure 1-2: RF Transmitter / Receiver Block Diagram

1.4 Referenced Documents

Table 1-3: Referenced Industry Documents

Source	Document No.	Rev/Date	Description
ARINC	429	1999	Mark 33 Digital Information Transfer System (DITS)
ARINC	718A	February 15, 2002	Mark IV Air Traffic Control Transponder (ATCRBS/Mode-S)
ARINC	735B	12/14/2007	Traffic computer TCAS and ADS-B functionality
RTCA	DO-160G	12/08/2010	Environmental Conditions and Test Procedures for Airborne Equipment
RTCA	DO-181E	03/17/2011	Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment
RTCA	DO-229D	12/13/2006	Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment
RTCA	DO-197A	09/12/1994	Minimum Operational Performance Standards for an Active Traffic Alert and Collision Avoidance System I (Active TCAS I)
RTCA	DO-254	04/19/2000	Design Assurance Guidance for Airborne Electronic Hardware
RTCA	DO-260B	12/02/2009	Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)
RTCA	DO-282B	12/2/2002	Minimum Operational Performance Standards for Universal Access Transceiver (UAT) automatic Dependent Surveillance Broadcast (ADS-B).

Table 1-4: Referenced ACSS Documents

Source	Document No.	Rev	Description
ACSS	8020130-006	-	NGT-9000 Environmental Qualification Evaluation Test Plan and Procedures
ACSS	8020132-001	-	NGT-9000 FCC Test Plan and Procedures
ACSS	8020132-002	B	NGT-9000 FCC Test Plan and Procedures Power Amp Qualification
ACSS	9000783-001	-	Switches, SPDT
ACSS	9001305	C	350W LDMOS Transistor
ACSS	9002396-001	-	Microcircuit, RF Switch, SPDT
ACSS	9020020-003	G	Circuit Card Assembly – NGT 9000D+
ACSS	9029000-20000	J	NGT-9000RD End Item Assembly
ACSS	9029000-40000	J	NGT-9000D End Item Assembly
ACSS	9200-17000-01	AG	Transponder Panel Mount With Diversity
ACSS	9200-17500-01	R	Transponder Remote Mount With Diversity

1.5 Acronyms and Abbreviations

Table 1-5: Acronyms and Abbreviations

Acronym	Description
AC	Alternating Current
ACSS	Aviation Communication and Surveillance Systems
ADS-B	Automatic Dependent Surveillance-Broadcast
AF	Audio Frequency
ARINC	Aeronautical Radio, Incorporated
CCA	Circuit Card Assembly
CFR	Code of Federal Regulations
DC	Direct Current
ECR	Engineering Change Request
EMI	Electromagnetic Interference
EQT	Environmental Qualification Testing
ESD	Electrostatic Discharge
FCC	Federal Communications Commision
HCIA	Hardware Change Impact Analysis
kHz	Kilohertz
LED	Light Emitting Diode
LRU	Line Replaceable Unit
MCU	Modular Concept Unit
MHz	Megahertz
Mod	Modification
N/A	Not Applicable
PSA	Power Supply Assembly
PTT	Push to Talk
P/N	Part Number
RF	Radio Frequency
RFA	Radio Frequency Transceiver Assembly
RIA	Rear Interconnect Assembly
RTCA	Radio Technical Commission for Aeronautics
SW	Switch
TPA	Transponder Processor Assembly
TSO	Technical Standard Order
VAC	Volts Alternating Current
VDC	Volts Direct Current

2 CCA DESIGN UPDATE

2.1 Executive Summary

The manufacturer of the 9000783-001 RF switch, Skyworks Solutions Inc., notified ACSS in February 2018 that the RF switch would be discontinued, with the last shipment in March 2019. The switch described by part number 9002396-001, made by Analog Devices under the HMC284AMS8G part number, is appropriate for use in the same applications, and will be used to support future production.

In addition, the manufacturer of the 9001305-001 RF power amplifier, STMicroelectronics, notified ACSS in January 2018 that they would be modifying the power amplifier packaging to address manufacturing yield and obsolescence issues. They are not modifying the die used to create the amplifier. This new version of the part is provided by the manufacturer as a form, fit, and function replacement for the power amplifier, and will be used as part number 9001305-002.

Both devices have the same footprint as the parts they replace and are not anticipated to affect the manufacturing process. Data provided by the manufacturers show equivalent performance, and engineering evaluations have also been performed without demonstrated issues. The data indicates that the component changes are low risk, but to ensure continued compliance with certification baselines additional environmental testing will be performed.

The RF power amplifierchange is being implemented as Hardware MOD C due to FCC certification considerations rather than any significant hardware impact. The original FCC certification has some defects that, when combined with more recent guidance from the FCC, result in resubmitting for FCC certification under a different FCC identifier.

2.2 FCC Considerations

The Lynx products were originally certified with data obtained via test procedure 8020132-001 and under the FCC ID 2ACTZMSS90. Subsequent review of recent guidance updates provided by the FCC as well as the original submittal revealed two issues:

1) The submittal incorrectly identified the Lynx products as being Maritime Transponders.
2) The FCC mandates that retested equipment can use the same identifiers as long as the test data matches the prior test results within 3dB. The prior test results incorrectly presented radiated emission levels at the noise floor and prevent subsequent test results from ever being within 3dB of the prior results.

To rectify the certification basis the Lynx products are being retested and will be resubmitted under the FCC ID 2ACTZMSS9019. This change necessitates a change in the labels as well as a hardware modification change to be able to track those LRUs covered by the new FCC ID. The label and modification changes are instituted at the end item level described by part numbers 9029000-20000 and 9029000-40000.

Since the basis of recertification includes the new STAC1011-350B, the 9001305 document is updated to describe the new part as the ACSS P/N 9001305-002. This new number causes revision of the 9020020-003 CCA, which may then be used to validate and track those LRUs conforming to hardware modification C.

2.3 Description of Hardware Changes

The 9020020-003 bill of materials is revised to allow the use of the 9002396-001 in lieu of the 9000783-001 RF switch. No changes to manufacturing processes or tests are required because the size, weight,

and construction are unaffected. No schematic or assembly documentation changes are required. The affected reference designators are U17, U66, U68, U69, U70, and U71.

The update to the RF amplifier is accomplished by revising the 9001305 document to include the 9001305-002 component. The 9020020-003 CCA is then updated to use the 9001305-002 (STAC1011-350B). The reference designator (Q73) and all assembly notes remain unchanged, only the parts list is affected.

The 9020020-003 CCA is used by all versions of NGT-9000 LRUs, so updating the single CCA addresses the component issues in all LRUs.

The specific function of the components at each reference designator is described in the following sections.

2.3.1 Power Amplifier

The power amplifier, Q73, provides the final amplification of modulated 1030MHz and 1090MHz, TAS and Transponder signals, to either the top or bottom antennas via PIN diode switches. The amplifier, shown in schematic excerpt Figure 2-1, and does not result in any additional component changes or modifications.

STMicroelectronics Inc. provided information about the package changes as well as early issues with oscillations in a document titled “STAC1011-350A Package Update5.pdf”, which is archived with this document within AIM. Subsequently, STMicroelectronics provided environmental performance test data on the updated component that included temperature, vibration, and shock testing on multiple samples in the document “STAC1011-350B-STAC780-Final Reliability Report.pdf” which is also archived with this document in AIM.

ACSS performed temperature testing using a hold-down mechanism which facilitated testing multiple amplifiers. Since solder was not involved, the hold-down mounting allowed the devices to oscillate. However, when mounted flush and with good CCA contact, the amplifiers met power and pulse fidelity requirements over temperature. Test data describing these tests and the results are included with this document in AIM in the document “Final Report on MLT PA Issues 2018.doc”.

The mechanical differences between the packages have been compared with no significant issues found. The dimension differences are shown in the included document “NGT-9000 PA 9001305-001 Package Dimension Differences.xlsx”.

The Design For Manufacturing analysis by Manufacturing Engineering and TTE China did not reveal any issues as shown in the email “RE: NGT-9000 PA 9001305-001 Package Dimension Differences.xlsx”, also included in AIM.

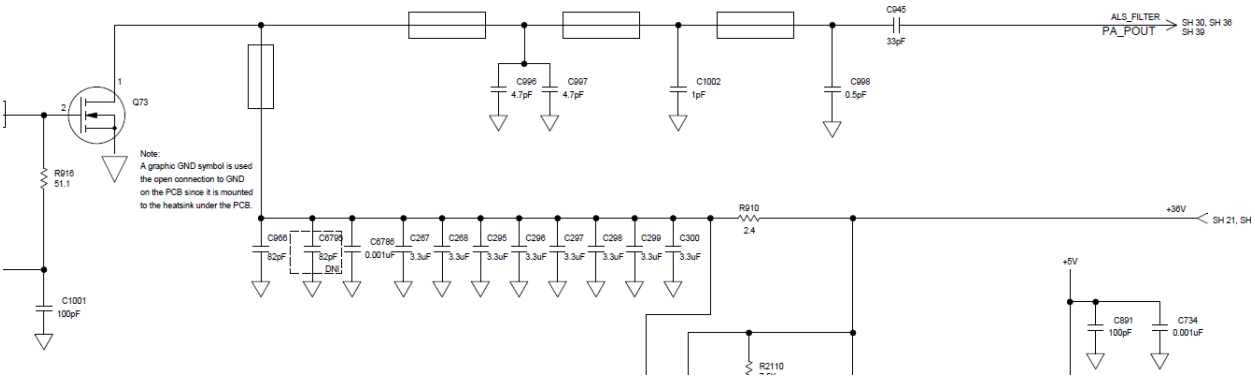

Figure 2-1: Power Amplifier Schematic Excerpt

2.3.2 RF Switch updates

The RF switches are used to for several functions including self-calibration, self-test, and controlling signal filter paths.

U69 and U70, as shown in Figure 2-2, direct small signal RF to either the 1030MHz or 1090MHz bandpass filters. These signals may be used for self-calibration, self-test, or for amplification and transmission depending on the state as controlled by the FPGA. Key characteristics for each switch are greater than 20dB isolation between the selected and unselected switch outputs so as to meet spectral mask requirements (40dBc) and switching times less than 600ns to support DO-181E transponder reply delay requirements.

U71 selects directing the filtered small signal RF to either be amplified for transmission or used for either calibration or self-test. In LRUs without the TAS function enabled, the switch may be bypassed by the resistors shown in the dashed-line squares because the 1030MHz transmissions are not needed. The key characteristic for the switch are greater than 20dB isolation between the selected and unselected switch output.

U68 directs self-test and calibration signals to either a 50ohm resistor or U17, the antenna Cal switch. The key characteristic for the switch is isolation greater than 20dB, as this switch assists in preventing undesired coupling to and from antenna ports.

U17 both isolates the self-test and transmitter filtering circuitry from the transmitter feedback signal while transmitting as well as directing the self-test signals between the antenna calibration port or to the receiver self-test switch. The key characteristics for the switch is isolation greater than 20dB.

The self-test switch, U66, directs the receiver self-test signals to either the top or the bottom antenna inputs or, when transmitting, directs the transmitter forward power feedback signal from the correct antenna. The key characteristic is switch isolation greater than 20dB to ensure that the correct top/bottom path is used for both self-test and transmitter feedback.

The schematic excerpts for these switches are shown in both Figure 2-2 and Figure 2-3.

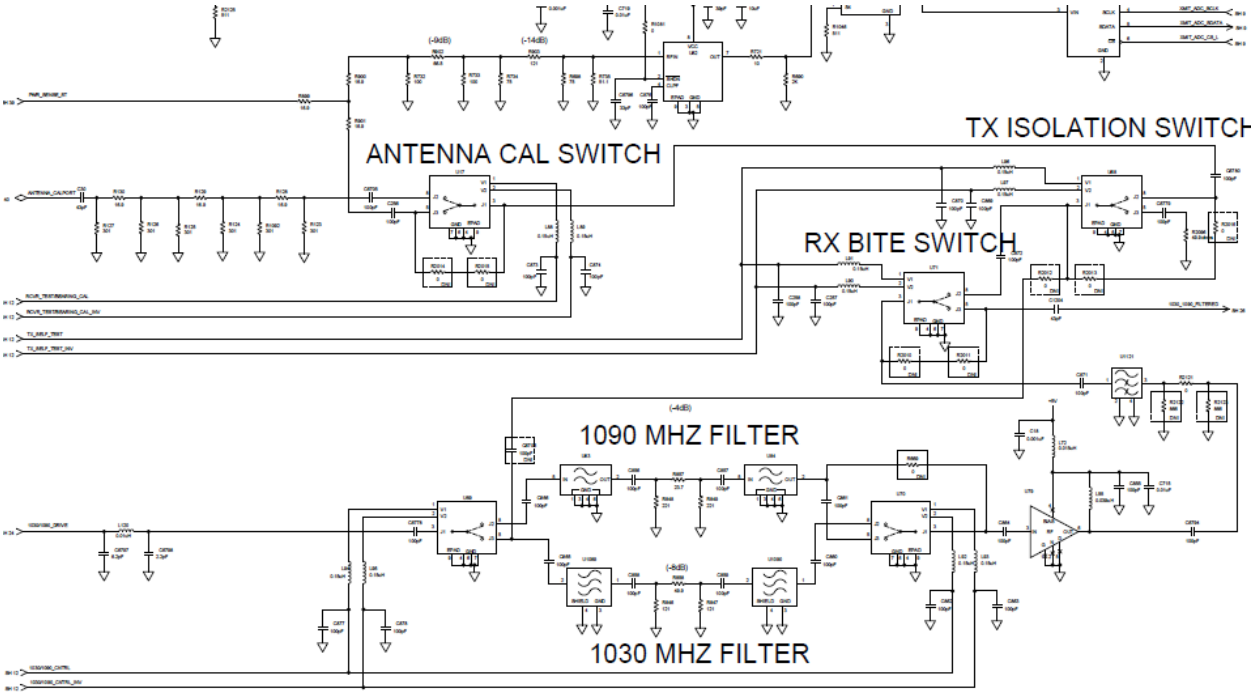

Figure 2-2: Schematic Excerpt, Transmitter Self-test Signal Routing

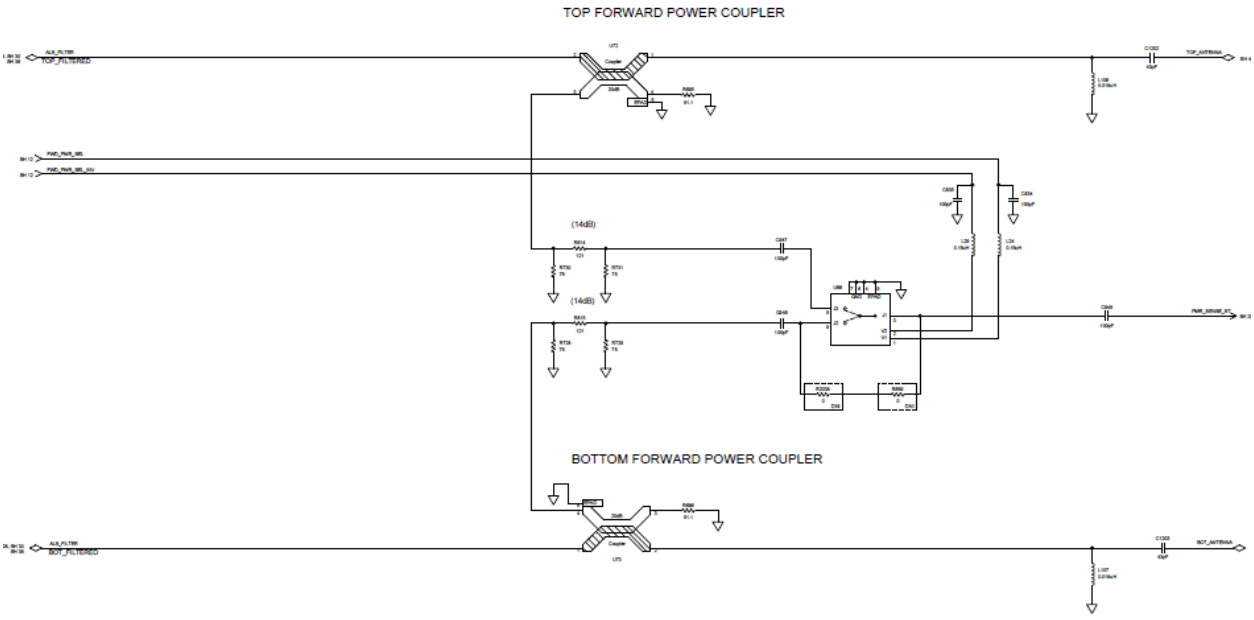

Figure 2-3: Schematic Excerpt, Transmitter Feedback or Receiver Self-test

A comparison of the manufacturer's datasheet specifications as shown in Table 2-1 demonstrated that the 9002396-01 meets or exceeds all of the stated specification except:

1) Noise BW: This is irrelevant as all applications are both narrowband and near 1GHz.
2) Isolation: The 9002396-001 has 9dB less isolation nominally, but has enough to ensure normal operation. This is demonstrated by failure-free operation over all the operating modes during temperature testing.
3) Control voltage: The control voltage maximum is 1/2V lower than the 9000783-001, but as the switch is driven by signals derived from regulated 5V sources, the 67% derating is well within the desired 80% guidelines.
4) Power input: The 9002396-001 maximum is 250mW (26dBm) vs 1000mW (30dBm) for the 9000783-001. The component most at risk is U66 because it is closest to the signal path of the very high power transmitted signal. The switch is isolated from the transmitted signal by both the directional coupler (20dB isolation) and the resistive 14dB attenuator. Thus, to exceed 250mW(26dBm), the transmitter would need to generate 26dBm + 20dB + 14dB = 60dBm (1000W). The power amplifier is only rated for 350W and is further isolated from the directional coupler by PIN diode switches and PCB losses. The reduction in maximum power handling capability still maintains high margins.
5) The 9000783-001 component specifies the switch will operate at 3V, while the 9002396-001 does not specify a lower limit.

In addition, the manufacturer datasheet specifications were compared against design parameters used in the transmitter design "budget". The 9002396-001 will meet the budget values, in some cases with more margin than the existing 9000783-001.

	9000783-001 Skyworks		9002396-001 ADI
	AS186-302LF	TX Budget	HMC284AMS8
Control Voltage (V)	5	5	5
Current (mA)			
Insertion Loss Nom. (dB)	-0.9	-0.8	-0.5
Insertion Loss Min at Cold (dB)		-0.7	
Insertion Loss Max at Hot (dB)	-1.05	-1	-0.6
NF nom (dB)		0.8	
NF T hot (dB)		1	
P-1 dB (dBm)	28	30	28
P-1 dB Cold (dBm)	28.5	30	
Output IP3 (dBm)	46	46	49
Noise BW (MHz)	4000	1000	3500
Switching Speed (ns)	50		20
Isolation (dB)	-55		-46
Absolute Max			
Control Voltage (V)	8		7.5
Id (mA)			
Pin (dBm)	30		26
Hot Switch Level (dBm)			18
Iref (mA)			
Pdiss (mW)			
Storage Temp (C)	-65 to 150		-65 to 150
Package	MSOP-8		MSOP-8

Table 2-1: Datasheet Specification Comparison

To verify the switching speed of the 9002396-001 demonstration card was obtained from the manufacturer. In the LRU, a differential driver (DS26C31) converts single ended logic signals from the FPGA to the differential signals needed by the RF switch devices. This differential driver can interact with the RF switch to affect switching time, so the combination of the switch on the demonstration card and driver was tested over temperature. The data from this testing is in the file “HMC284 Demo Card data.xls”, and is archived in AIM with this document. A summary of the test results is shown in Table 2-2, which demonstrates that the combined switch speed is much faster than the 600ns PIN diode switches as well as being very consistent over temperature.

T_{HL} = time from 50% to RF falls 20dBc.				
T_{LH} = Time from 50% to RF rises to -1dBc.				
	T_{HL}		T_{LH}	
T chambe	Time	File Name	Time	File Name
+25C	36ns	Screen0024.BMP	76ns	Screen0023.BMP
100C	40ns	Screen0052.BMP	80ns	Screen0025.BMP
-50C	34ns	Screen0053.BMP	70ns	Screen0054.BMP

Table 2-2: 9002396-001 Switching Speed over Temperature.

Additional temperature testing was performed on a related product. A T3CAS 9005000-55 TEQ01118 was selected to screen for suitability in this application because:

1) T3CAS is the source design from which the Lynx circuits were copied, and uses the same switch drivers and 5V rails.
2) T3CAS uses 29 of the RF switches, so it provides more opportunities to demonstrate issues if they exist.
3) The T3CAS product has higher power transmissions and is specified for more sensitive receptions than the Lynx product. Again, it provides more opportunities to demonstrate issues.

The T3CAS LRU was calibrated in the factory and shown to pass all pre-test, ESS, and final tests. The RF switches were then replaced with the proposed 9002396-001 and the tests repeated without recalibration. All factory tests again passed without any noted degradation. The factory test data is included in AIM with this document.

3 CHANGE ANALYSIS

3.1 Complex Electronic Hardware Changes

No Complex Electronic Hardware changes occurred.

3.2 Software Changes

No software changes occurred.

3.3 Failure Functional Analysis

There is no known Lynx Failure Functional Analysis due to the changes.

3.4 TSO Change Impact Analysis

The Lynx product is approved to the following TSOs:

- ATCRBS/Mode S Transponder Function:
  - TSO-C112d
- Airborne Multipurpose Electronic Display Function (9029000-20000 only):
  - TSO-C113a
- GPS Function:
  - TSO-C145c
- Traffic Advisory (TAS) Function:
  - TSO-C147
- Universal Access Transceiver (UAT) Function:
  - TSO-C154c
- Flight Information Services-Broadcast (FIS-B) Function:
  - TSO-C157a
- Automatic Dependent Surveillance-Broadcast (ADS-B) Function:
  - TSO-C166b
- Avionics Supporting ADS-B Operation Function:
  - TSO-C195a

The impact of the change affects hardware only. Because of this, all TSO related hardware functions will be validated via system level testing during the applicable environments.

The hardware changes described herein do not meet the 14 CFR 21.619(b) Major change criteria of requiring a substantially complete investigation to determine compliance with the applicable TSO's. Therefore, the 9029000-XXXXX HW Mod C is a Minor TSOA change.

3.5 Conclusion

All changes affect hardware only and has an insignificant affect with regards to the functionality and manufacturability of the LRU. Therefore, it is submitted as a **Minor change impact** Category 3.

4 ENVIRONMENTAL QUALIFICATION TESTING

Environmental Qualification Testing (EQT) Emissions and Susceptibility will be performed on the Lynx panel mount P/N 9200-17000-01 LRU according to the DO-160G environmental categories summarized in Table 4-1 and as described in the procedure document 8020130-006.
The Panel mount LRU was selected for EMI testing because all affected hardware is in common between the panel mount and the remote LRU (P/N 920-17500-001), the panel mount includes the added complexity of the display, and because the display increases the aperture and hence the risk during EMI testing. Temperature and Humidity may be performed using either the Remote Mount (P/N 920-17500-01) or the panel mount because the affected components are used in exactly the same manner on both assemblies. Performance under environmental conditions based on the various TSO requirements is specified in the Environmental Qualification Test Plan and Procedures, 8020130-006. However, unlike previous qualification efforts, during EMI and Susceptibility the panel mount LRU will be tested with the cable connectors facing the antennas because of a change to the installation kit planned to be evaluated concurrently with the changes described in this document.

Additionally, since the power amplifier change could affect the results of FCC mandated tests, these tests will also be performed to evaluate the impact. This testing, described in 8020132-002, includes transmitter power, modulation, occupied bandwidth, and spurious emissions. Radiated spurious emission testing is performed on both the NGT-9000D (panel mount) and the NGT-9000RD (remote mount) due to differences in the display and mounting orientation. The same CCA's/connectors/cables are used on both panel and remote mount LRUs, so testing involving the RF cables may be tested on only one version and be applicable to both LRU versions.

Table 4-1: Summary of Environmental Test Conditions

DO-160G Section		Means of Compliance	Justification
4.5.1 thru 4.5.4	Temperature	Test	The functionality of the new components will be tested over the specified temperature range. Since RF transmissions and receptions are what are affected by the proposed changes, the RF Susceptibility operational tests will be used to verify performance during this testing.
4.5.5	In-Flight Loss of Cooling	Analysis	No retest needed. The proposed replacements are the same size, mounting, and technology with no changes in power dissipation or part temperature rating.
4.6	Altitude, Decompression, & Overpressure	Analysis	No retest needed. The proposed replacements are the same size, mounting, and technology with no changes in power dissipation or part temperature rating.
5	Temperature Variation	Test	The functionality of the new components will be tested over the specified temperature variation range. Since RF transmissions and receptions are what are affected by the proposed changes, the RF Susceptibility operational tests will be used to verify performance during this testing.
6	Humidity	Test	Humidity will be retested per 8020130-002 because of the repackaging of the power amplifier. Since RF transmissions and receptions are what are affected by the proposed changes, the RF Susceptibility operational tests will be used to verify performance during this testing.
7.1	Operational Shocks	Analysis	No retest needed. The mass and physical geometry of the components are nearly the same as the former components.

DO-160G Section		Means of Compliance	Justification
7.2	Crash Safety	Analysis	No retest needed. The mass and physical geometry of the components are nearly the same as the former components.
8	Vibration	Analysis	No retest needed. The mass and physical geometry of the components are nearly the same as the former components.
9	Explosive Atmosphere	Not Required	Product not certified to these requirements.
10	Waterproofness	Not Required	Product not certified to these requirements.
11	Fluids Susceptibility	Not Required	Product not certified to these requirements.
12	Sand and Dust	Not Required	Product not certified to these requirements.
13	Fungus	Not Required	Product not certified to these requirements
14	Salt Spray	Not Required	Product not certified to these requirements.
15	Magnetic Effect	Analysis	No retest needed. The proposed replacements are the same size, mounting, and technology with no addition of nickel, iron, or ferrous material
16	Power Input – Electrical Power Input Parameter Limits (DC)	Analysis	No retest needed. The component changes are not on the DC power input and do not affect power supply loading in any way.
17	Voltage Spike	Analysis	No retest needed. The component changes are not on the DC power input and do not affect power supply loading in any way.
18	AF Conducted Susceptibility	Analysis	No retest needed. The component changes are not on the DC power input and do not affect power supply loading in any way.
19	Induced Signal Susceptibility	Analysis	No retest needed. The component changes are not on the DC power input and do not affect power supply loading in any way.
20	RF Susceptibility	Test (Radiated) Not Applicable (Conducted)	Radiated susceptibility will be performed. All updates relate to the RF switching and reception of transmitted and received frequencies. These frequencies of interest and their harmonics are well above 400MHz, the maximum test frequency for conducted susceptibility. No conducted tests is required because of the low upper frequency at which testing is performed.
21	Emission of RF Energy	Test (Radiated) Not Applicable (Conducted)	Radiated emissions testing will be performed. All updates relate to the RF switching and reception of transmitted and received frequencies. These frequencies of interest and their harmonics are well above 152MHz, the maximum test frequency for conducted emissions. No conducted tests are required due to the low upper frequency of conducted emissions testing.
22	Lightning Induced Transient Susceptibility, including customer specified transients	Analysis	No retest needed. None of the changes are on interface circuitry or are part of the protection against induced lightning transients.
23	Lightning Direct Effects	Not Required	Product not certified to these requirements.
24	Icing	Not Required	Product not certified to these requirements.
25	Electrostatic Discharge (ESD)	Analysis	No retest needed. None of the changes are on interface circuitry or are needed to withstand ESD.
26	Fire, Flammability	Not Required	Product not certified to these requirements.

END OF DOCUMENT